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Article

The Relationship between Socioeconomic Factors and Nutritional Intake in Older Female Cancer Survivors

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Abstract

Healthy diet has been shown to promote disease-free cancer survivorship and improve health-related quality of life (HRQoL) among older adults (≥65 years). However, socioeconomic factors such as education and income that may influence diet are understudied. This study examined the influence of income and education on the diet of older female cancer survivors, while investigating disparities in HRQoL. Older female survivors completed surveys to assess HRQoL (RAND-36), diet quality (Diet History Questionnaire II), demographic and clinical characteristics. Descriptive analyses, correlations, and stepwise linear regressions were utilized. Participants (n=171) were, on average, 72.72±7.40 years old, white (90%) and breast cancer survivors (68%). Thirty-six percent had low-income and 44% had high-income, while 45% had low education and 54% had high education. Average physical and mental HRQoL scores were 41.94±10.50 and 48.47±7.18 out of 100. The mean HEI-2015 score was 66.54±10.01 out of 100. Higher education was associated with higher HEI scores (β=0.417, p=0.032) and higher mental HRQoL (β=0.574, p=0.004). In conclusion, participants were found to have low HRQoL and

suboptimal diets for promoting disease-free survivorship. Diet and HRQoL were associated with education. Results indicate need for nutritional screening and increased access to dietitians who can facilitate behavior change throughout survivorship.

I. Introduction

Due to advances in treatment and management, 67% of individuals diagnosed with cancer will now survive 5 or more years.[1] Of the more than 16.9 million cancer survivors in the United States today, 64% are older adults (≥65 years).[2] This percentage is only expected to grow, as older adults are the fastest growing segment of the population and are the age group most likely to be diagnosed with cancer.[1,3] By 2060, it is estimated that one in four Americans will be over the age of 65.[4] Notably, the majority of older adults are female; as there are only 89 males for every 100 females in the 65 to 74 age group.[3] In 2020, it is estimated that more than 1.8 million individuals will be diagnosed with cancer.[1] Despite higher cancer incidence among women than men, it is estimated that more men will die from cancer than women.[1] These statistics and estimates indicate that older female cancer survivors are a significant and growing survivor population. Older female cancer survivors have unique health needs, as older survivors are more likely to have functional limitations than cancer-free older adults and may experience varying long-term health effects because of treatment.[2,5] Common late-effects of cancer treatment include chronic neuropathy, cardiomyopathy, cognitive impairment, and osteoporosis.[2,6] Similarly, for older adults in general, advanced age is a risk factor for chronic diseases such as chronic obstructive pulmonary disease, cardiovascular disease, and type 2 diabetes.[7,8] In addition to the risk of developing chronic disease, older survivors may also be at high risk of developing second primary cancers.[9,10] These consequences of aging and cancer diagnosis may worsen survivor's health-related quality of life (HRQoL).[11] HRQoL is a self-perceived measure that includes domains related to physical, psychological, and social aspects of health, including health

conditions, functional status, and socioeconomic status (SES).[12] It is particularly important for older survivors to follow dietary guidelines that may help prevent chronic disease and cancer recurrence.[7,13] Van Blarigan et al. found that cancer survivors that followed American Cancer Society (ACS) nutrition and physical activity guidelines had longer overall survival than those that did not.[14] The ACS guidelines[15] emphasize a diet rich in vegetables, fruits, and whole grains while limiting alcohol and red meat consumption, which coincides with guidelines set by the American Institute for Cancer Research (AICR)[16] and the Dietary Guidelines for Americans[17]. Nutritional intake is frequently measured by Healthy Eating Index (HEI) scores, which range from 0 to 100 and quantify the extent to which individuals followed the Dietary Guidelines for Americans in the past year. Following these dietary recommendations can also assist in the management of conditions common in the aging population such as sarcopenia and immune deficiency.[7] Thus, nutritional intake, a modifiable lifestyle behavior, is a valuable target for intervention in an older cancer survivor population. There is strong evidence supporting the importance of healthy diet and weight management in promoting disease-free cancer survivorship.[11,14,18] However, older cancer survivors are particularly susceptible to nutritional deficiencies due to age-related metabolic, sensory, and physical changes.[7,19] Sensory changes may include altered taste, smell, or vision while physical changes may include a loss of muscle mass or teeth.[20,21] These changes can negatively influence the dietary habits of older female cancer survivors. Prior research found that while daily recommendations for sodium intake are far exceeded, many older females do not meet daily whole grain or protein intake recommendations.[22,23] Nutritional deficiency

in older adults is associated with several negative health outcomes including decline in functional status, immune dysfunction, and reduced cognitive function.[24] Despite the known importance of dietary behavior in this population, nutritional issues among older adult survivors is an understudied area of research.[25] The nutritional choices of older females are particularly important because they are more likely than older men to be responsible for household meal preparation.[26] A variety of factors can influence food choice within this population. In addition to the aging-related changes noted previously, social factors such as living situation, size of social network, and SES have all been found to influence the nutritional intake of older adults.[27,28] Two of the most important SES factors that influence nutritional intake are income and education, as limited finances and high costs were among the top reported barriers to good nutrition for older females and educational attainment has been found to be predictive of diet quality.[28-31] Previous studies[32,33] found SES-related nutritional disparities among older adults, as those with lower income and education were found to have worse nutritional intake. However, studies investigating the social factors that may influence the nutritional intake of older female survivors are not evident in the literature. Moreover, evidence regarding the influence of income, education, and nutritional intake on HRQoL within this population is limited. Two baseline characteristics of older female survivors have been shown to influence their nutritional intake. First, older women tend to have higher HEI scores than older men[34], and second, individuals with a history of cancer tend to have higher HEI scores than individuals without a history of cancer.[35] Furthermore, the HEI scores of older adults have been found to increase with both income[32,36] and educational attainment.[32,34]

In a survivor population, Kane et al.[37] found that survivors with a college degree had higher HEI scores than those without a college degree. Regarding HRQoL, previous studies found that multiple lifestyle factors, such as maintaining a normal body weight and healthy diet, are associated with better overall HRQoL.[11,38-42] Income, additionally, has been identified as an important predictor of HRQoL among older survivors.[43] Moreover, lower diet quality and higher financial burden have been associated with lower self-rated health among older adults.[44,45] However, a gap remains as none of these studies specifically investigated the nutritional intake of older female cancer survivors. This study aims to fill this gap by examining the association of income and educational attainment with the nutritional intake and HRQoL of older female cancer survivors, providing results that may be used to identify disparities within this underserved population and to identify survivors more likely to become malnourished. The authors hypothesize that older female cancer survivors with higher education and income will have better nutritional intake and higher HRQoL.

II. Methods

This study was a secondary study utilizing previously collected data from a parent, cross sectional study. To be eligible for the parent study, participants must be older adults, female, cancer survivors who have completed primary cancer treatment (i.e. received chemotherapy, surgery, and/or radiation) within the past five years, and are able to complete a survey in English. A five-year limit was used to ensure the accuracy of diet-related changes after cancer diagnosis. All cancer types and stages were eligible and women receiving adjuvant hormone therapy were included. Older female cancer survivors were recruited to participate in the survey either during follow-up visits to the [BLINDED] Geriatric Oncology Clinic or

through medical records obtained from the cancer center's registry. During follow-up visits, prospective participants were provided with a recruitment flyer containing the study coordinator's name and contact information. When prospective participants in the cancer center's registry were identified as meeting the eligibility criteria, the study coordinator received their name and mailing address. A recruitment letter was subsequently sent to these potentially eligible patients to explain the survey and ask them to contact the study coordinator if interested. Women who contacted the study coordinator were screened to ensure they met all eligibility criteria and then informed of the study's goals. These women were then asked if they were willing to participate and if so, they could complete the survey online or request a survey via mail or telephone. Online surveys were taken via Research Electronic Data Capture (REDCap), a secure web application developed for clinical research. In total, 1,200 women who met the eligibility criteria were contacted for participation, 215 expressed interest in participating and 44 expressed interest but did not respond to follow-up attempts. As 171 women completed surveys, the response rate was 14.3%. 89 (52%) participants completed the survey on paper, 80 (46.8%) completed the survey on REDCap, and 2 (1.2%) completed the survey over the telephone. Prior to the start of the survey, informed consent was obtained from all participants. Additionally, each participant consented to a HIPAA waiver to collect demographic and clinical characteristics from their medical records. Participants who completed the survey online were informed that proceeding with the survey denotes their consent to participate in the survey. All participants received a $10 gift card for their time. The [BLINDED] Institutional Review Board approved the informed consent procedures and study protocol. A REDCap-

based survey was used to assess the physical, emotional, social, and nutritional well-being of participants, while also collecting demographic and clinical information. The survey administered the 36-Item Health Survey (RAND-36)[46,47], eight-item modified Medical Outcomes Study Social Support Survey (mMOS-SS)[48], two-item USDA measure of food insecurity[49,50], the Malnutrition Screening Tool (MST)[49-51], and the Diet History Questionnaire II (DHQII).[52] The survey also collected demographic and clinical information including self-reported chronic conditions, weight gains/changes associated with cancer diagnosis and treatment, cooking, and grocery shopping. For the purposes of this study, the primary measures utilized were the RAND-36 and DHQII, along with self-reported household income and educational attainment. The *RAND-36: T36-Item Health Survey* is composed of eight subscales assessing individual aspects of HRQoL during the previous four weeks: physical functioning, role functioning physical, pain, general health, energy/fatigue, social functioning, role functioning emotional, emotional well-being. Responses to these items are on a Likert scale, but can be converted to scores ranging from 0-100, with 100 as the highest score possible for each subscale.[46,47] For example, a question about feeling tired had responses ranging from "all of the time" to "none of the time," and was evaluated with related questions to yield a numerical energy/fatigue subscale score. Moreover, a physical health composite score (PCS) and mental health composite score (MCS) can be created from the subscales for each. In this study, PCS and MCS were used as measures of physical and mental HRQoL, respectively. Self-rated health was separately measured by a single question with responses ranging from "poor" to "excellent." The *Diet History Questionnaire*

(DHQII) was developed by the National Cancer Institute and consists of 134 food item questions and 8 dietary supplement questions.[52] The food item questions measure dietary intake over the past 12 months considering portion size, frequency, preparation methods, dietary restrictions, as well as alcohol intake. DHQII scores can be converted to HEI total scores. HEI total scores range from 0-100 and include 13 components that describe the extent to which individuals followed dietary recommendations over the previous year, with 100 indicating ideal following of the Dietary Guidelines for Americans[17]. Of the 13 components, 9 assess adequacy of healthy intake and 4 assess moderation of unhealthy intake. For the adequacy components, greater consumption yields higher scores. For the moderation components, greater consumption yields lower scores. Generally, HEI scores >80 indicate a "good" diet, scores ranging from 51 to 80 reflect a diet that "needs improvement," and HEI scores <51 imply a "poor" diet.[53] This study utilized HEI-2015 scores, as nutritional intake was relative to the 2015-2020 Dietary Guidelines for Americans.[17] Participants provided self-reported demographic information including age, gender, race, and ethnicity. Participants also self-reported SES information including educational attainment and household income. These variables were analyzed as independent SES factors. Household income was assessed as combined income from all sources, including wages, salaries, Social Security, and help from relatives. Response options were "less than $20,000," "$20,001-$50,000," "$50,001-$100,000," "$100,000+," "I don't know," and "I prefer not to answer." Educational attainment response options were "less than grade school," "grade school," "high school diploma," "GED," "some college or technical/trade school," "associate degree,"

"bachelor's degree," "master's degree," "professional degree," "doctorate degree," and "I prefer not to answer." For the purposes of this study, household income was dichotomized as either lower-income (</= $50,000) or higher-income (> $50,000), while educational attainment was dichotomized as either lower-education (less than a 4-year college degree) or higher-education (at least a 4-year college degree). Additional information regarding participant's clinical characteristics (e.g., date of cancer diagnosis, AJCC (American Joint Committee on Cancer) stage at diagnosis, treatments received (i.e. chemotherapy, surgery, and/or radiation), cancer recurrence, other chronic conditions, prescription regimen, lab results, etc.) were collected through medical record review. Body mass index (BMI) was calculated for each participant from their reported height and weight in kg/m^2. Based on Centers for Disease Control and Prevention guidelines, BMI was divided into 6 categories: underweight (<18.5), normal weight (18.5 to <25), overweight (25 to <30), Class 1 obese (30 to <35), Class 2 obese (35 to <40), and extreme obesity (≥40).[54] Lastly, risk for malnourishment was measured via the Malnutrition Screening Tool (MST)[49] which is measured by 3 questions. The 3 questions inquire about decreased appetite, unintentional weight loss, and amount of weight loss within the last six months. Descriptive statistics (i.e. frequencies, means, standard deviations) were used for the demographic and health characteristics, HEI-2015 total and subcomponent scores, and HRQoL subscale and subcomponent scores. Based on the 2015-2020 Dietary Guidelines for Americans[17], DHQII scores were converted to HEI-2015 scores by the National Cancer Institute utilizing SAS 24 and Diet*Calc.[55] To compare mean PCS, MCS, self-rated health, and HEI-2015 scores by demographic and clinical

characteristics, multiple t-tests, and analysis of variances (ANOVAs) with Bonferroni post-hoc analyses were utilized. Pearson's correlations were utilized to assess potential associations among individual characteristics (e.g., age, race, education, income, BMI, chronic conditions, cancer type, AJCC stage at diagnosis, time since diagnosis, treatments received), PCS, MCS, HEI-2015 total score, and self-rated health. Stepwise linear regressions were conducted to assess potential associations between income, education, PCS, MCS, HEI-2015 total score, and self-rated health while controlling for demographic and health characteristics. IBM SPSS Statistics version 26.0 was used for all analyses.

III. Results

Participants had a mean age of 72.72±7.40 and were mostly white (90.0%) and breast cancer survivors (68.0%). Approximately 36% of participants were lower-income (</=$50,000) and approximately 44% of participants were higher-income (>$50,000), with the remaining 20% preferring not to answer. Approximately 45% of participants had lower-education (less than a 4-year college degree) and approximately 54% had higher-education (at least a 4-year college degree). The mean BMI of participants was 27.7±6.2, with much of the sample being classified as overweight (31.0%) or obese (32.7%). According to the MST, 27.2% of participants were found to be at risk for malnourishment. Participants most frequently indicated that their self-rated health was good (40.0%) or very good (42.4%). (Table 1)The average PCS and MCS scores of participants were 41.94±10.50 and 48.47±7.18, respectively, out of 100. The lowest HRQoL subcomponent score was for energy/fatigue, with an average score of 42.74±9.90. Conversely, the highest subcomponent score was for social functioning, with an average score of 82.50±21.11 (Table 2).

The mean HEI-2015 score among participants was 66.54±10.01. In terms of percent of maximum possible score, the lowest scoring food components were whole grains (27.0%) and fatty acids (47.3%) while the highest scoring food components included total protein foods (91.4%), whole fruit (90.6%), and total vegetables (86.4%). Among the moderation food components, for which lower consumption yields higher scores, participants had low scores for sodium (50.2%) and saturated fat (53.6%) (Table 3). In Table 4, potential differences in mean self-rated health, PCS, MCS, and total HEI-2015 scores were reported by the sample's demographic and clinical characteristics. Significant differences in self-rated health were found between the high- and low-income groups (p=0.005), as participants with higher household incomes had significantly higher self-rated health. There were significant differences in the mean PCS score by educational attainment (p=0.043), household income (p=0.001), and BMI (p=0.002). Individuals with lower educational attainment, lower household income, and higher BMI had lower PCS scores. Similarly, there were significant differences in mean MCS by educational attainment (p=0.009), as participants with lower educational attainment had lower MCS scores. Thus, participants with at least a 4-year college degree were found to have significantly higher PCS and MCS scores. Significant differences in mean HEI-2015 score were evident between high and low income (p=0.029) as well as high and low education (p=0.001) groups. Specifically, participants with an income below $50,000 (p=0.029) or less than a 4-year college degree (p=0.001) had significantly lower total HEI-2015 scores. Correlations were found between self-rated health, PCS, MCS, total HEI-2015 scores, and demographic and clinical characteristics. A higher total HEI-2015 score was associated with higher

educational attainment (r=0.249, p=0.001), higher income (r=0.224, p=0.009), higher self-rated health (r=0.211, p=0.006), higher PCS (r=0.339, p<0.001), and higher MCS (r=0.171, p=0.044). Higher self-rated health was associated with having higher income (r=0.206, p=0.017), a lower BMI (r=-0.245, p=0.001), fewer chronic conditions (r=-0.336, p<0.001), as well as a higher PCS (r=0.632, p<0.001) and MCS (r=0.249, p=0.003). Higher PCS was also associated with higher education (r=0.173, p=0.043), higher income (r=0.315, p<=0.001), lower BMI (r=-0.342, p<0.001), and fewer chronic conditions (r=-0.336, p=0.001). Higher MCS was associated with older age (r=0.257, p=0.002) and higher education (r=0.222, p=0.009) (Table 5). Stepwise linear regressions determined associations between income, education, self-rated health, HEI-2015 scores, PCS, and MCS. Controlling for demographic and clinical characteristics, having higher PCS was associated with higher self-rated health (β=0.679, p=0.001) while having higher self-rated health (β=0.750, p<0.001) and surgical treatment for primary cancer (β=0.316, p=0.028) was associated with higher PCS. Higher PCS (β=0.430, p=0.028), along with higher educational attainment (β=0.417, p=0.032), was also found to be associated with higher total HEI-2015 scores. Lastly, educational attainment (β=0.574, p=0.004) was found to be associated with higher MCS (Table 6).

IV. Discussion

The aim of this study was to investigate the association between nutritional intake and the SES factors income and education among older female cancer survivors. HRQoL and self-rated health were also investigated to evaluate SES-related disparities within this underserved population. Income and education were examined to help identify characteristics that may influence an older female cancer

survivor's diet quality. The diet quality of survivors is important because inadequate nutritional intake is associated with reduced survival and impaired quality of life.[56,57] Older survivors, in particular, may struggle to maintain an adequate diet due to aging-related changes such as diminished appetite, difficulties chewing or swallowing, and family adjustments like losing a spouse that normally prepared meals. Thus, it is particularly important to identify the social factors that may be associated with inadequate nutritional intake. Results indicated that older female cancer survivors have low HRQoL and poor diet quality, on average. While educational attainment was found to be associated with both HRQoL and nutritional intake, income was not found to be associated with either HRQoL or nutritional intake, after adjusting for social and demographic variables. In the present study, the mean total HEI-2015 score was 66.54 out of 100, with mean component scores of 4.17 out of 5, 4.32 out of 5, and 2.70 out of 10 for total fruits, total vegetables, and whole grains, respectively. Using National Health and Nutrition Examination Survey data, Bluethmann et al. found that the mean total HEI-2015 score of older adults was 64 out of 100, with mean component scores of 3.7, 4.0, and 4.0 for total fruits, total vegetables, and whole grains, respectively.[58] One explanation for the higher total diet quality score in this study could be that the majority of participants were white and highly educated, as these characteristics have been associated with higher HEI scores.[32] Alternatively, this finding could be due to participant's survivor status, as older cancer survivors have been found to have higher HEI scores than older adults without a history of cancer.[35] This higher diet quality may explain why only 27.2% of participants in this study were found to be at risk for malnutrition according to the MST, as this is

a relatively low percentage compared to previously reported at-risk percentages for adult populations of cancer survivors (32%, 36%).[59,60] Notably, while the mean HEI-2015 score observed in this study was above average for older adults, it still falls within the "needs improvement" category, indicating that many older female cancer survivors do not consume the recommended diet known to help prevent cancer recurrence and chronic disease.[13,14] Dietary guidelines[15-17] for cancer survivors specifically, and Americans in general, emphasize a diet rich in vegetables, fruits, and whole grains. The mean HEI-2015 component scores for these foods indicated that participants in this study consumed more total fruits and more total vegetables, but less whole grains, than the general older adult population. This finding parallels research by Inoue-Choi and colleagues[11], which found that older female cancer survivors are more likely to adhere to fruit and vegetable intake recommendations than to whole grain intake recommendations. Depending on factors such as age, gender, race, and SES, cancer survivors have been found to both over-and under-estimate their diet quality on food frequency questionnaires, particularly for fruit and vegetable intake, which complicates interpretation.[61] For example, it was found that older age, higher income, and higher education were strongly associated with cancer survivors being over-estimators, so it is feasible that participants over-estimated their fruit and vegetable intake.[61] In contrast to HEI-2015 scores, the mean PCS (41.94) and MCS (48.47) scores of study participants were below average compared to previously reported ranges for PCS (40.2-45.2) and MCS (47.6-54.0) scores among older female cancer survivors.[11,39,62,63] Despite these lower HRQoL scores, nearly 90 percent of participants self-rated their health as "good," "very good," or

"excellent," which coincides with previous findings among older women.[64] Considering SES, physical HRQoL was lowest among participants with low incomes and mental HRQoL was lowest among participants with low educational attainment. Moreover, self-rated health was higher among participants with higher income and education. Considering disease burden, both self-rated health and physical HRQoL were lower among those with a high BMI and more chronic conditions. These findings, that both HRQoL and self-rated health generally decrease as SES decreases and disease burden increases, are supported by the literature.[39,64,65] Additionally, both physical and mental HRQoL were found to be associated with HEI-2015 scores. Thus, HRQoL was found to be associated with both nutritional intake and BMI, which coincides with the literature showing that improvements in lifestyle behaviors can lead to increased HRQoL.[11,40,41,66,67]

After adjusting for demographic and health characteristics, higher physical HRQoL and higher educational attainment were the only factors found to be associated with higher HEI-2015 scores. Similarly, higher educational attainment was the only factor associated with higher mental HRQoL. The link between educational attainment and HEI-2015 scores is supported by the literature, as education has consistently been identified as a factor influencing nutritional intake among older adults.[27,28,32] One potential explanation is the association between higher educational attainment and higher health literacy.[68,69] Health literacy is a multifaceted concept that entails a person's ability and motivation to access, understand, and apply health information in their lifestyle and healthcare decisions. Older adults are the age group most likely to have inadequate health literacy, particularly those with low SES and those belonging to minority populations.[70-73] Among older

breast cancer survivors, Halbach et. al[74] found that nearly half had limited health literacy. The association between education and health literacy may be mediating the study findings because individuals with higher health literacy tend to have healthier nutritional intake.[71,75,76] In relation, the finding that educational attainment is associated with mental HRQoL may also be related to health literacy, as cancer survivors with lower health literacy have been found to have lower quality of life scores.[77-79] The findings of Nilsen and colleagues[78] are particularly supportive of the results in this study, as they found that health literacy was significantly associated with mental, but not physical, HRQoL. Among older adults, maintaining a healthy diet and body weight has consistently been associated with improved health outcomes and HRQoL throughout survivorship.[11,16,38,67,80] Thus, one potential strategy to improve the health outcomes and HRQoL of older female cancer survivors is implementing interventions that target modifiable lifestyle behaviors, such as diet and exercise. This study indicated that the educational attainment of an older female cancer survivor is associated with her nutritional intake and HRQoL. Considering the literature which shows that health literacy is associated with nutritional intake and HRQoL, and the findings of this study that education is associated with nutritional intake and HRQoL, interventions to improve health literacy and knowledge of healthy lifestyle behaviors may improve the nutritional intake and HRQoL of older female cancer survivors. At a minimum, it is crucial for providers to consider a patient's educational attainment and level of health literacy when implementing a lifestyle intervention, so as not to exacerbate the existing disparity between older female cancer survivors with differing educational attainment. Moreover, to help prevent

nutritional deficiencies and potential health disparities, clinicians and dietitians should consistently use validated assessments to examine the dietary intake of all older cancer survivors throughout survivorship. Currently, nutritional screening of cancer patients and survivors is limited and warrants improvement. One method of improving screening may be to increase dietitian staffing, as the average ratio of registered dietitians to patients in outpatient cancer centers has been reported as 2,308:1.[81] Among older adults, an active learning lifestyle intervention has been shown to improve health literacy, dietary variety, and physical activity levels.[82] Furthermore, tailoring patient education interventions to health literacy levels has been shown to be effective among older adults.[83] For older cancer survivors in particular, previous lifestyle behavior interventions[40,84-89] concerning diet, exercise, and weight management have been shown to improve health outcomes and HRQoL. For example, Demark-Wahnefried et al.[90] found that individually-tailored lifestyle interventions lead to long-lasting improvements in dietary quality and physical functioning among older cancer survivors. Despite the growing body of evidence highlighting the positive effect of healthy eating on health outcomes among cancer survivors, the specific associations of dietary quality among older female cancer survivors remain under-studied.[40,44,91-94] Further research on the social factors and educational interventions that influence the nutritional intake of older female cancer survivors is warranted. For it's strengths and limitations, this study had several distinct strengths. First, this study utilized several assessment tools, the RAND-36[46,47], MST[49-51], and DHQII[52], validated for use by older adults and cancer survivors. Moreover, the numerous domains represented in the RAND-36 and DHQII assessments provided

a broad understanding of individual characteristics within each domain. Second, in contrast to the existing literature investigating the HRQoL and nutritional intake of older female cancer survivors, this study was inclusive of survivors of various cancer types, as many past studies[38,40,41] included only breast cancer survivors. In this study, although 68% of participants were breast cancer survivors, the remaining 32% included hematologic, gynecologic, and gastrointestinal cancer survivors, hence providing results more generalizable to the older female cancer survivor population. This study was limited in that it was cross-sectional and thus did not measure changes in nutritional intake or HRQoL over the course of cancer treatment or survivorship. Additionally, while demographic and clinical variables were adjusted for, there were unmeasured variables such as health literacy that may have influenced the associations between income, education, nutritional intake, and HRQoL. As noted previously, the results of this study may have been influenced by participants under- or over-estimating their diet quality and the extent to which their health status affects their quality of life, particularly if participants answered questions in ways they felt were socially desirable. The measurement of nutritional intake was further limited in that the DHQII can underestimate consumption of fiber and whole grains due to the lack of questions regarding whole grain products, as well as the misunderstanding of "whole grain" vs. "whole wheat" on product labels.[95] Also, because the cutoffs for high/low education and income in this study fell above national medians for income and education level among older adults, the results may not reflect differences in nutritional intake and HRQoL between other, non-dichotomous SES levels.[96] Lastly, this study's generalizability is limited due to a smaller

sample size and limited demographic variability, as participants were recruited from one cancer center and the majority were breast cancer survivors with higher educational attainment and income levels.

V. Conclusions

This study sought to examine the nutritional intake, self-rated health, and HRQoL of older female cancer survivors with respect to household income and educational attainment. Results indicated that participants, on average, had less than ideal diet quality and low HRQoL. Educational attainment was found to be associated with both nutritional intake and HRQoL. In contrast, income was found to not be associated with nutritional intake or HRQoL, after adjusting for demographic and clinical characteristics. The importance of nutritional intake in promoting disease-free cancer survivorship, and the associations between social factors and health-promoting lifestyle behaviors, need to be recognized and further explored. The health outcomes of older female cancer survivors could be improved if nutritional intake were tracked throughout survivorship, and educational interventions to promote health behaviors and improve health literacy were delivered.

Supplementary Material:

Table 1. Demographic and health characteristics of older female cancer survivors*

Demographic	**N (%)**
Age (mean (SD))	72.72 (7.40)
Age at diagnosis, (mean (SD))	66.63 (9.40)
Race	
White	144 (90)
Black	13 (8.1)
Asian	2 (1.3)
Other	1 (0.6)
Education Level	
Less than high school	2 (1.2)
High School/GED	26 (15.3)
Some College/Associate's degree	48 (28.2)
College graduate/Graduate degree	93 (54.7)
Household Income	
Less than $20,000	17 (10.1)
$20,001-$50,000	44 (26.0)
$50,001-$100,000	47 (27.8)
$100,000+	27 (16.0)
Health Characteristics	
Self-rated Health	
Fair	18 (10.6)
Good	68 (40.0)
Very Good	72 (42.4)
Excellent	12 (7.1)
Cancer type	
Breast	90 (68)
Hematologic	18 (14)
Gynecologic	15 (11)
Other	9 (7)
Months since Diagnosis (mean (SD))	65.81 (62.56)
AJCC Stage at Diagnosis	

0	8 (13.1)
1A/2B	27 (44.3)
2A/2B	22 (36.1)
3B/3C	4 (6.6)
Treatment Received	
Radiation	107 (70.9)
Surgery	108 (71.5)
Chemotherapy	69 (45.7)
BMI, (mean (SD))	27.7 (6.2)
BMI Category	
Underweight	4 (2.4)
Normal Weight	57 (33.9)
Overweight	52 (31.0)
Class 1 Obese	34 (20.2)
Class 2 Obese	14 (8.3)
Extreme Obesity	7 (4.2)
Malnutrition Screening Tool Mean Score	1.04 (1.83)
At risk for malnourishment	44 (27.2)
Number of Chronic Conditions (mean (SD))	2.4 (1.9)

Note: Other cancers include lung, kidney, pancreas, colon, skin, maxillary sinus AJCC=American Joint Committee on Cancer
*=Not all categories equal n=171 due to missing data

Table 2. Health-related quality of life among older female cancer survivors

Variables	**Mean (SD)**
HRQoL subscales	
Physical composite score (PCS)	41.94 (10.50)
Mental composite score (MCS)	48.47 (7.18)
HRQoL subcomponents	
Physical functioning	59.76 (24.07)
Role limitations due to physical health	60.82 (42.01)
Role limitations due to emotional problems	81.30 (34.28)
Energy/Fatigue	42.74 (9.90)
Emotional well-being	64.97 (10.39)
Social functioning	82.50 (21.11)
Pain	72.73 (22.28)
General health	59.40 (15.33)

Table 3. Mean Healthy Eating Index 2015 (HEI) scores of older female cancer survivors

Components	**Maximum Points Possible**	**Mean Scores (SD)**	**Percent of Maximum Scores**
Total HEI Score	100	66.54 (10.01)	66.54
Adequacy:			
Total Vegetable	5	4.32 (1.03)	86.4
Greens and Beans	5	3.91 (1.43)	78.2
Total Fruit	5	4.17 (1.26)	83.4
Whole Fruit	5	4.53 (1.01)	90.6
Whole Grains	10	2.70 (1.76)	27.0
Dairy	10	6.09 (2.72)	60.9
Total Protein Foods	5	4.57 (0.82)	91.4
Seafood and Plant Proteins	5	4.51 (0.95)	90.2
Fatty Acids	10	4.73 (3.12)	47.3
Moderation:			
Sodium	10	5.02 (2.86)	50.2
Refined Grains	10	8.94 (1.75)	89.4
Added Sugars	10	7.69 (2.91)	76.9
Saturated Fats	10	5.36 (3.24)	53.6

Table 4. Mean Self-rated Health, HEI, PCS and MCS scores by socioeconomic characteristics and lifestyle behaviors

Variable	**Self-rated Health (SD)**	**PCS Mean (SD)**	**MCS Mean (SD)**	**Total HEI Mean (SD)**
Race				
White	3.50 (0.79)	42.46 (10.66)	48.71 (6.97)	66.78 (9.93)
Black	3.00 (0.71)	38.36 (9.82)	45.49 (9.59)	65.08 (11.27)
Other	3.67 (0.58)	42.11 (10.58)	48.41 (7.23)	69.37 (4.49)
p-value[a]	*0.118*	*0.423*	*0.343*	*0.487*
Educational Attainment[b]				
Less than 4-year College Degree	3.37 (0.75)	39.94 (11.77)	46.61 (8.42)	64.04 (9.87)
4-year College Degree	3.53 (0.80)	43.61 (9.23)	49.80 (5.66)	68.99 (9.45)
p-value[a]	*0.153*	*0.043*	*0.009*	*0.001*
Household Income				
Equal to or less than $50,000	3.28 (0.78)	38.39 (10.47)	48.50 (8.81)	63.96 (9.20)
More than $50,000	3.59 (0.70)	44.89 (9.25)	49.38 (5.02)	68.53 (10.58)
p-value[a]	*0.005*	*0.001*	*0.506*	*0.029*
Cancer Type				
Breast	3.48 (0.80)	42.81 (10.67)	47.91 (7.16)	67.03 (9.74)
Hematologic	3.67 (0.59)	43.17 (8.12)	52.07 (3.61)	67.74 (10.01)
Gynecologic	3.40 (0.74)	44.54 (10.36)	47.05 (9.18)	67.19 (8.30)
Other	3.11 (0.93)	38.30 (11.34)	48.48 (8.72)	67.07 (9.59)
p-value[a]	*0.318*	*0.586*	*0.181*	*0.888*
AJCC Stage at Diagnosis				
0	3.38 (0.52)	46.90 (7.61)	46.97 (8.41)	66.59 (7.89)
1A/1B	3.48 (0.70)	44.10 (9.75)	46.82 (6.47)	67.17 (8.94)
2A/2B	3.55 (0.96)	42.70 (11.25)	47.68 (7.57)	67.47 (12.13)
3B/3C	3.00 (0.00)	34.55 (6.62)	43.38 (10.04)	70.53 (9.81)
p-value[a]	*0.668*	*0.324*	*0.829*	*0.953*
Treatment Received				

Radiation	3.50 (0.77)	42.57 (10.29)	49.60 (7.00)	65.90 (10.06)
No Radiation	3.41 (0.84)	41.11 (11.06)	47.23 (6.50)	68.36 (9.93)
p-value[a]	*0.367*	*0.492*	*0.090*	*0.326*
Surgery	3.50 (0.77)	42.68 (10.28)	49.60 (6.96)	66.19 (10.15)
No Surgery	3.40 (0.85)	40.79 (11.07)	47.16 (6.59)	67.70 (9.84)
p-value[a]	*0.295*	*0.380*	*0.083*	*0.494*
Chemotherapy	3.53 (0.76)	43.22 (9.76)	48.56 (6.84)	67.69 (10.75)
No Chemotherapy	3.43 (0.82)	41.33 (11.03)	49.24 (7.02)	65.71 (9.39)
p-value[a]	*0.785*	*0.324*	*0.594*	*0.137*
BMI Categories				
Underweight	4.00 (0.82)	42.37 (12.22)	47.52 (10.51)	62.87 (13.63)
Normal Weight	3.65 (0.83)	46.05 (10.20)	49.01 (5.44)	69.38 (9.51)
Overweight	3.45 (0.70)	42.45 (8.66)	46.80 (8.15)	64.92 (9.92)
Class 1 Obese	3.29 (0.80)	37.66 (10.87)*	49.32 (9.02)	63.82 (9.97)
Class 2 Obese	3.14 (0.66)	40.21 (10.58)	49.32 (9.02)	68.86 (8.88)
Extreme Obesity	3.14 (0.69)	32.20 (9.45)*	49.49 (8.47)	62.57 (12.19)
p-value[a]	*0.051*	*0.002*	*0.614*	*0.168*

[a]p-values for mean differences between groups based on T-test and ANOVA analyses;

[b]PCS and MCS data missing for the two individuals with less than high school education

*Significant differences in PCS scores of class 1 obese and extreme obesity groups compared to normal weight (p=0.007 and p=0.026), respectively.

Table 5. Correlation analyses between demographic characteristics, health, and dietary quality *=p<0.05; **=p<0.01

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Age	--															
2. Race	-.065	--														
3. Education	-.061	-.013	--													
4. Income	-.131	-.142	.379**	--												
5. BMI	-.115	.057	-.151	-.166	--											
6. Chronic Conditions	.008	-.149	.037	.057	.281**	--										
7. Cancer Type	.151	-.025	-.124	-.169	-.104	-.138	--									
8. Cancer Stage	-.064	.193	.100	-.054	-.128	.066	.017	--								
9. Time since diagnosis	-.031	.067	.119	.123	.088	.118	.014	-.407**	--							
10. Surgery	.020	.066	.024	-.009	-.073	-.040	.061	.225	.006	--						
11. Radiation	.019	.066	.040	-.062	-.071	-.026	.061	.225	.006	.952**	--					
12. Chemotherapy	.016	.010	.022	.061	-.014	-.089	-.110	-.016	.091	.166*	.149	--				
13. Self-rated Health	.098	-.103	.105	.206*	-.245**	-.336**	-.089	-.036	-.118	.063	.052	.065	--			
14. PCS	-.080	-.083	.173*	.315**	-.342**	-.310**	-.069	-.029	-.042	.080	.063	.090	.632**	--		
15. MCS	.257**	-.112	.222**	.063	.043	.050	.042	-.091	.096	.158	.154	-.049	.249**	-.038	--	
16. Total HEI Score	.015	-.008	.249**	.224**	.105	-.004	-.013	.050	-.006	-.068	-.111	.099	.211**	.339**	.171*	--

Table 6. Predictors of Self-rated Health, Total HEI Scores, Physical Health Composite Scores (PCS), and Mental Health Composite Scores (MCS) among Older Female Cancer Survivors

Predictors	*B*	SE *B*	β	p-value
Self-rated Health				
PCS	.049	.012	.679	0.001
Total HEI Scores				
PCS	.577	.243	.430	0.028
Educational attainment	10.050	4.356	.417	0.032
PCS				
Self-rated Health	9.989	1.779	.750	<0.001
Surgery for primary cancer	5.404	2.287	.316	0.028
MCS				
Educational attainment	8.140	2.537	.574	0.004

Note: R^2=.433, p=0.001 for Self-rated Health; R^2=.318, p=0.010 for HEI scores; R^2=.608, p=0.000 for PCS; R^2=.297, p=0.004 for MCS

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